MODULE *OnlineShoppingPlatform*

IMPORTS

EXTENDS
Naturals,
Integers,
Sequences,
TLC,
FiniteSets

CONSTANTS
Shoppers, Set of customers $\sim$ *RM* (Resource Manager)
Products Set of products (available / unavailable)

ASSUME
$Cardinality(Shoppers) > 0 \quad \land$
$Cardinality(Products) \geq 0$

**** Supporting methods ****

$IsInjective(f) \triangleq \forall\, a,\, b \in \text{DOMAIN } f : f[a] = f[b] \Rightarrow a = b$

$SetToSeq(S) \triangleq \text{CHOOSE } f \in [1 \,..\, Cardinality(S) \to S] : IsInjective(f)$

****

$Customers \triangleq [Shoppers \to 1 \,..\, 5]$ The set of all arrays indexed by the elements of *Shoppers* indexed with values from inte

$Commodities \triangleq [Products \to 1 \,..\, 2]$ Index of the products represents individual prices

VARIABLES *shopperState*, *availableProducts*, *customers*, *commodities*, *boughtProducts*, *commodity*, *availablePr*

$vars \triangleq \langle shopperState,\, availableProducts,\, customers,\, commodities,\, boughtProducts,\, commodity,\, availableProd$

$State \triangleq (Shoppers)$

Type Control Invariants

$TCTypeOK \triangleq shopperState \in [Shoppers \to \{\text{“idle”},\, \text{“browsing”},\, \text{“selecting”},\, \text{“ordering”},\, \text{“shipped”},\, \text{“served”}\}]$

Global variables

$$\begin{aligned} TCInint \triangleq\ & \land shopperState = [shopper \in Shoppers \mapsto \text{“browsing”}] \\ & \land customers \in Customers \\ & \land commodities \in Commodities \\ & \land bought = \{\} \\ & \quad \text{Variables for the states of actual shopping activities} \\ & \land availableProductsSet \in [Shoppers \to \text{SUBSET DOMAIN } commodities] \\ & \land availableProducts = [shopper \in Shoppers \mapsto SetToSeq(availableProductsSet[shopper])] \end{aligned}$$

$\land\ availableProductsIndex = [shopper \in Shoppers \mapsto 1]$
$\land\ boughtProducts = [shopper \in Shoppers \mapsto \{\}]$
$\land\ commodity = [shopper \in State \mapsto 0]$

Shopper is on the web page and selects its *product(s)*

$ProductsBrowsing(shopper) \triangleq \land\ shopperState[shopper] = \text{“browsing”}$
$\land\ shopperState' = [shopperState \text{ EXCEPT } ![shopper] = \text{“browsing”}]$ All other sho
$\land\ \text{UNCHANGED } \langle customers, commodities, boughtProducts, availableProducts, a$

Shopper tries to select the product (add to basket)

$ProductSelection(shopper) \triangleq \land\ shopperState[shopper] = \text{“selecting”}$
$\land\ \text{IF } availableProductsIndex[shopper] \leq Len(availableProducts[shopper])$
$\text{THEN } \land\ commodity' = [commodity \text{ EXCEPT } ![shopper] = availableProducts[$
$\land\ \text{IF } commodity[shopper] \in bought$
$\text{THEN } \land\ \text{FALSE}$
$\text{ELSE } \land\ shopperState' = [shopperState \text{ EXCEPT } ![shopper] = \text{“orde}$
$\text{ELSE } \land\ shopperState' = [shopperState \text{ EXCEPT } ![shopper] = \text{“served”}]$
$\land\ \text{UNCHANGED } commodity$
$\land\ \text{UNCHANGED } \langle customers, commodities, boughtProducts, availableProducts, a$

Shopper procceds to the basket finalize the order

$ProductOrdering(shopper) \triangleq \land\ shopperState[shopper] = \text{“ordering”}$
$\land\ \text{IF } commodities[commodities[shopper]] \leq customers[shopper]$
$\text{THEN } \land\ customers' = [customers \text{ EXCEPT } ![shopper] = customers[shopper]$
$\land\ boughtProducts' = [boughtProducts \text{ EXCEPT } ![shopper] = boughtPro$
$\land\ bought' = (bought \cup commodities[shopper])$
$\text{ELSE } \land\ \text{TRUE}$
$\land\ \text{UNCHANGED } \langle customers, bought, boughtProducts \rangle$
$\land\ shopperState' = [shopperState \text{ EXCEPT } ![shopper] = \text{“selecting”}]$
$\land\ \text{UNCHANGED } \langle commodities, availableProducts, availableProductsIndex, availa$

Shopper ordered product and specifies shippment

$ProductShipping(shopper) \triangleq \land\ shopperState[shopper] = \text{“shipping”}$
$\land\ shopperState' = [shopperState \text{ EXCEPT } ![shopper] = \text{“served”}]$
$\land\ \text{UNCHANGED } \langle availableProducts, customers, commodities, boughtProducts, co$

Shopper does not do anything at all – *TODO*: Integrate this state

$NonActive(shopper) \triangleq \land\ shopperState[shopper] = \text{“idle”}$
$\land\ (shopperState' = [shopperState \text{ EXCEPT } ![shopper] = \text{“served”}] \lor shopperState' = [s$
$\land\ \text{UNCHANGED } \langle availableProducts, customers, commodities, boughtProducts, commod$

State *Automat* formula of the Online Store

$OnlineShopping(shopper) \triangleq \land\ ProductsBrowsing(shopper)$
$\lor\ ProductSelection(shopper)$

$\lor\ ProductOrdering(shopper)$
$\lor\ ProductShipping(shopper)$

TERMINATION ASSERTIONS

$Terminating \triangleq\ \land (\forall\, shopper \in State : shopperState[shopper] = \text{“served”})$
$\land\ \text{UNCHANGED}\ vars$

$Next \triangleq\ (\exists\, shopper \in Shoppers : OnlineShopping(shopper))$
$\lor\ Terminating$

$Spec \triangleq\ TCInit \land \Box[Next]_{vars}$

$Termination \triangleq\ \Diamond(\forall\, shopper \in State : shopperState[shopper] = \text{“served”} \lor shopperState[shopper] = \text{“browsing”}$